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Effect of nutrient and weed management strategies on the yield performance of *boro* rice cv. BRRI dhan63

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ABSTRACT

An experiment was conducted to study the yield components and yield of *boro* rice (cv. BRRI dhan63) under different nutrient and weed management strategies. The experiment was laid out in a two factor randomized complete block design with three replications consisting of four nutrient management strategies *viz.* cowdung 10 t ha^{-1}, recommended dose of chemical fertilizer (urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate @ 258, 101, 120, 113 and 11.5 kg ha^{-1}, respectively), 75% recommended dose of chemical fertilizer + cowdung 5 t ha^{-1} and 50% recommended dose of chemical fertilizer + cowdung 10 t ha^{-1}; and five weed management strategies *viz.* weedy check, hand weeding twice at 15 and 30 days after transplanting (DAT), pre-emergence herbicide Panida at 3 DAT, post-emergence herbicide Granite at 10 DAT and Panida at 3 DAT + Granite at 10 DAT. Yield components and yield of *boro* rice cv. BRRI dhan63 were significantly influenced by nutrient and weed management strategies. Application of 75% recommended dose of chemical fertilizer + cowdung 5 t ha^{-1} showed the highest values for all yield components and produced the highest grain yield (6.24 t ha^{-1}) while among the weed management strategies, Panida at 3 DAT + Granite at 10 DAT produced the highest grain yield (6.39 t ha^{-1}) and the interaction of this two treatments also produced the highest grain yield (6.97 t ha^{-1}). Among the different nutrient management strategies, cowdung 10 t ha^{-1} produced the lowest values of most of the yield contributing characters and grain yield (4.92 t ha^{-1}) while in case of weed management strategies weedy check produced the lowest grain yield (4.55 t ha^{-1}) and the interaction of this two treatments also produced the lowest grain yield (4.05 t ha^{-1}). Therefore, it can be concluded that 75% recommended dose of chemical fertilizer + cowdung 5 t ha^{-1} combined with Panida at 3 DAT + Granite at 10 DAT can be practiced for the cultivation of *boro* rice cv. BRRI dhan63 to obtain the highest grain yield.

Keywords: Cowdung, granite, herbicide, panida, post-emergence, pre-emergence

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1 Introduction

Rice is the vital food for more than two billion people in Asia and four hundred millions of people in Africa and Latin America (IRRI, 2006). Bangladesh is one of the major rice growing countries of the world. Bangladesh is in fourth position among the top rice growing countries. In Bangladesh, total rice production was 34.6 million tons (BBS, 2016). Agriculture contributes 14.8% of national economy of Bangladesh (BBS, 2016) and only the rice sector contributes one-half of the agricultural GDP and about one-sixth of the national income in Bangladesh. In Bangladesh, there are three diverse growing seasons of rice namely- *aus*, *aman* and *boro*. Among different rice groups of Bangladesh *boro* rice covers 4.8 million ha, which is 41.9% of total rice area with production of 18.9 million tons (BBS, 2016). Although *boro* rice has the highest yield but still there is a serious yield gap. In Bangladesh, lack of judicial nutrient and weed management are considered as the major causes of yield gap in rice production.

As the fertility status of Bangladesh soils are very low farmers normally apply chemical fertilizers as the principal source of plant nutrients for rice production but their loss is very high (especially for nitrogen). Therefore, any alternative means has to be suggested to the farmers to maintain the high level of productivity. That's why, integrated use of organic manures such as cowdung and chemical fertilizers can be an effective solution for nutrient management in rice as well as to sustain long term productivity and to enhance ecological sustainability.

Application of cowdung may play an important role in rice cultivation when used alone or in combination with chemical fertilizers. The application of cowdung to soil is considered as a good management practice in any agricultural production system because of the stimulation of soil microbial growth and activity, subsequent mineralization of plant nutrients and increased soil fertility and quality (Islam et al., 2007). Moreover, global environmental pollution can be controlled considerably by reducing the use of chemical fertilizer and increasing the use of cowdung as organic manure.

Weed is considered as one of the noxious enemies of crop wasting economic inputs massively. Globally, actual yield losses due to pests have been estimated approximately 40%, of which weeds causes the highest loss (32%) (Rao et al., 2007). Weeds rank first in reducing yields (34%) of major crops world-wide (Jabran et al., 2015). On average, rice yield loss due to weed ranges from 15 to 20%, but in severe cases the yield loss may exceed 50% (Hasanuzzaman et al., 2009) or even 100% (Mishra and Singh, 2007; Jayadeva et al., 2011). In Bangladesh, severe weed infestation reduces the grain yield by 70-80% in *aus* rice (early summer), 30-40% for transplanted *aman* rice (Late summer) and 22-36% for modern *boro* rice (winter rice) (Mamun, 1990; BRRI, 2008). Timely weeding is, therefore, necessary for higher grain yield and better economic return.

In Bangladesh, hand weeding is the traditional method of weed control but it is becoming less popular as it is very much laborious and time consuming. In large scale rice farming, herbicide based weed management has become the smartest and most viable option as against the scarcity and high costs of labor (Singh et al., 2006; Anwar et al., 2012). Mechanical methods (*i.e.* Japanese rice weeders) of weeding are in use in some areas of the country. But due to some inconveniences, these have not gained wide spread popularity. Herbicides are effective in controlling weeds alone or in combination with hand weeding (Ahmed et al., 2005). The use of herbicides in the country has been 37-fold increase in the last three decades (BBS, 2017; Islam et al., 2018). However, uninterrupted use of the same herbicides for a long period may cause severe environmental pollutions (Aktar et al., 2009; Islam and Kato-Noguchi, 2014), develop herbicide resistant weeds, and cause shifts in weed flora (Holt, 1994). Despite such unwanted after effects, no viable alternative is currently available to shift the chemical dependence for weed management in rice. After all it is necessary to sort out the most effective weed management technique(s) to reduce weed infestation and maximize rice yield.

From the above discussion we can say that it is very important to find out the appropriate nutrient and weed management techniques for improving the yield of *boro* rice. This research was therefore initiated to reveal these facts.

2 Materials and Methods

2.1 Experimental site and soil

The experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh in order to study the interaction effect of nutrient and weed management strategies on the performance of *boro* rice cv. BRRI dhan63. The experimental field was located at 24°43′8.3″N, 90°25′41.2″E at an average altitude of 18 m above the mean sea level. The experimental site belongs to the Old Brahmaputra Floodplain Agro-ecological zone (AEZ-9). The experimental field belongs to non-calcareous dark-grey, floodplain soil. The land was medium high and the soil was silty-loam and medium fertile. The soil of the experimental field was more or less neutral in nature (pH 6.82) and low in organic matter content (1.19%).

Table 1. Description of herbicides that were used in the experiment

Trade name	Common name	Mode of action	Selectivity	Time of application
Panida 33 EC	Pendimethalin	Systemic	rice, potato	Pre-emergence
Granite 240 SC	Penoxsulam	Systemic	rice	Post-emergence

2.2 Experimental treatments and design

The experiment was laid out in a two factor randomized complete block design with three replications consisting of four nutrient management strategies *viz.* N_1 (cowdung 10 t ha^{-1}), N_2 (recommended dose of chemical fertilizer *i.e.* urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate @ 258, 101, 120, 113 and 11.5 kg ha^{-1}, respectively), N_3 (75% recommended dose of chemical fertilizer + cowdung 5 t ha^{-1}) and N_4 (50% recommended dose of chemical fertilizer + cowdung 10 t ha^{-1}); and five weed management strategies *viz.* W_0 (weedy check or no weeding), W_1 (hand weeding twice at 15 and 30 days after transplanting (DAT)), W_2 (pre-emergence herbicide, Panida 33 EC @ 2.5 L in 500 L water ha^{-1} applied at 3 DAT), W_3 (post-emergence herbicide, Granite 240 SC @ 94 ml in 500 L water ha^{-1} applied at 10 DAT) and W_4 (pre-emergence herbicide, Panida 33 EC @ 2.5 L in 500 L water ha^{-1} applied at 3 DAT + post-emergence herbicide, Granite 240 SC @ 94 ml in 500 L water ha^{-1} applied at 10 DAT). The size of the unit plot was 10 m^2 (4 m $\times$ 2.5 m) and the spaces between blocks and plots were 1 m and 0.5 m, respectively.

2.3 Experimental materials

2.3.1 Plant material (BRRI dhan63)

This variety was developed by BRRI from the cross between Iranian variety Amol-3 and BRRI dhan28 in 2014. It is a long duration *boro* rice variety (148-150 days). Its fertilizer use efficiency is high and flag leaf is straight and long. The average yield of this variety is 6.5-7 t ha^{-1}. This variety have fine grain and similar quality like Balam thats why it is known as Fine Balam. It has long grain like Pakistani Basmati. Grain contain 25% amylose and 8.2% protein (BRRI, 2016).

2.3.2 Cowdung (CD)

Cowdung (CD) may play a vital role in soil fertility management as well as supplying primary, secondary and micronutrients for crop production. Cowdung contains 0.5% N, 0.3% P_2O_5, 0.5% K_2O, 0.3% Ca and 0.1% Mg (Mahabub et al., 2016). Application of CD may play an important role in rice cultivation when used alone or in combination with chemical fertilizers.

2.3.3 Applied herbicides

A short description of herbicides that were used in the experiment is given in Table 1.

2.4 Crop husbandry

Sprouted rice seeds were sown in the wet nursery bed on 26 november 2016. Forty three days old seedlings were transplanted in the puddled main field using two seedlings $hill^{-1}$ on 8 January 2017. Bangladesh Rice Research Institute (BRRI) recommended dose of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate for the used variety were 258, 101, 120, 113 and 11.5 kg ha^{-1}, respectively. All the fertilizers were applied to the respective plots as per treatments recommendation. All other fertilizers except urea were applied to the respective plots at one day before transplanting. Urea was applied in three equal splits at 15, 30 and 45 DAT. Well decomposed cowdung was applied at seven days before transplanting to the respective plots as per treatments recommendation. Intercultural operations were done as and when necessary. Different weed management strategies were followed properly as per treatments. The flood irrigation was applied to maintain a constant level of standing water up to 6 cm in early stage to enhance tillering and 10-12 cm in later stage to discourage late tillering. The field was finally drained out before 15 days of harvest to enhance maturity. Plants were infested with rice stem borers and leafhoppers which were successfully controlled by applying Basudin 10G @ 20 kg ha^{-1}. Malathion 57EC was also applied @ 1 L ha^{-1} to control other insects.

2.5 Data collection

Five hills (excluding border hills) were randomly selected from each unit plot prior to harvest for recording data on plant characters, yield and yield components. The date of harvesting was determined when 90% of the grains became golden yellow in colour. An area of central 1 m^2 was harvested in each plot to record the yields of grain and straw. The harvested crop was then threshed, cleaned and dried to a moisture content of 14%. Weight of grain and straw were recorded and converted into t ha^{-1}. At harvest all weeds of each plot were collected and dried in the oven at 85$\pm$5 °C temperature until constant weight was reached to record the weed dry matter (g m^{-2}).

2.6 Statistical analysis

Data obtained were analyzed by MSTATC-statistical computer package program using the 'Analysis of variance' (ANOVA) technique at 5% level of significance and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

3 Results and Discussion

3.1 Effect of nutrient management

Nutrient management strategies exerted significant influence on yield and yield contributing characters of *boro* rice cv. BRRI dhan63 (Table 2). Nutrient management strategies significantly influenced all the parameters at 1% level of probability except panicle length and 1000-grain weight (Table 2). The highest grain yield (6.24 t ha^{-1}) and straw yield (7.39 t ha^{-1}) was recorded in N_3 (75% recommended dose of chemical fertilizer + cowdung 5 t ha^{-1}) due to highest number of total tillers $hill^{-1}$ (10.77), effective tillers $hill^{-1}$ (8.99) and grains $panicle^{-1}$ (85.23) (Table 2). Kant and Kumar (1994) also found increased number of grains $panicle^{-1}$ with combined application of organic manure and inorganic fertilizer. Application of organic manure (cowdung 5 t ha^{-1}) in combination with chemical fertilizer (75% recommended dose of chemical fertilizer) might have positive influence on soil health and sufficient nutrients availability resulting in the highest number of total tillers $hill^{-1}$, effective tillers $hill^{-1}$ and grains $panicle^{-1}$, which were mainly responsible for the highest grain and straw yield in N_3. The biological yield (13.63 t ha^{-1}) and harvest index (45.78%) were also observed highest in N_3. In contrast, the lowest grain yield (4.92 t ha^{-1}) and straw yield (6.10 t ha^{-1}) were recorded in N_1 (cowdung 10 t ha^{-1}) due to lowest number of total tillers $hill^{-1}$ (6.79), effective tillers $hill^{-1}$ (5.85) and grains $panicle^{-1}$ (80.66) (Table 2). Insufficient supply of plant nutrients from cowdung 10 t ha^{-1} might be the cause of lowest grain and straw yield in N_1 treatment. Similar results were also reported elsewhere (Islam, 2009; Marzia et al., 2016).

3.2 Effect of weed management

All the yield contributing characters and yield of *boro* rice (cv. BRRI dhan63) except panicle length were significantly influenced by weed management strategies (Table 3). The highest number of total tillers $hill^{-1}$ (10.08), effective tillers $hill^{-1}$ (8.54), number of grains $panicle^{-1}$ (84.92) and 1000-grain weight (23.95 g) were recorded in W_4 (Panida at 3 DAT + Granite at 10 DAT), those assisted in highest grain yield (6.39 t ha^{-1}) and straw yield (7.62 t ha^{-1}) for this treatment (Table 3). The highest biological yield (14.01 t ha^{-1}) and harvest index (45.60%) were also found in W_4 (Table 3). This might be due to the appropriate weed management in case of W_4 which kept the land relatively more weed free and soil was well aerated which facilitated the crop for better absorption of nutrients, moisture and solar radiation for higher yield. Effective weed management enhanced the production of effective tillers $hill^{-1}$ and grains $panicle^{-1}$ which ultimately increased the grain yield of rice. Datta (1990) revealed that effective weed management increased number of effective tillers $hill^{-1}$ due to more availability of water, nutrients and light. On the contrary, no weeding (W_0) produced the lowest number of total tillers $hill^{-1}$ (8.36), effective tillers $hill^{-1}$ (7.09), grains $panicle^{-1}$ (80.81) and 1000-grain weight (21.30 g) with highest number of sterile spikelets $panicle^{-1}$ (24.82), those assisted lowest grain yield (4.55 t ha^{-1}) and straw yield (5.72 t ha^{-1}) for W_0 (Table 3). Biological yield (10.27 t ha^{-1}) and harvest index (44.27%) were also lowest in W_0 (Table 3). In no weeding treatment, competition for nutrients between weeds and rice plants was severe which resulted in decreased numbers of total tillers $hill^{-1}$, effective tillers $hill^{-1}$ and reduced number of grains $panicle^{-1}$ thus the lowest grain yield. Similar results were also reported elsewhere (Sinha et al., 2018; Islam et al., 2018).

3.3 Effect of interaction between nutrient and weed management

It was found that number of total tillers $hill^{-1}$, number of effective tillers $hill^{-1}$, grain yield, straw yield and biological yield were significantly influenced by the interaction between nutrient and weed management strategies (Table 4). The highest number of total tillers $hill^{-1}$ (12.20) and effective tillers $hill^{-1}$ (10.13) were found in treatment interaction $N_3 \times W_4$ (75% recommended dose of chemical fertilizer + cowdung 5 t ha^{-1} × Panida at 3 DAT + Granite at 10 DAT). The treatment interaction $N_3 \times W_4$ produced the highest grain yield (6.97 t ha^{-1}) which was statistically identical with $N_3 \times W_1$ (75% recommended dose of chemical fertilizer + cowdung 5 t ha^{-1} × hand weeding twice at 15 and 30 DATs) (6.73 t ha^{-1}) (Table 4). Straw yield (8.50 t ha^{-1}) and biological yield (15.47 t ha^{-1}) were also highest in case of $N_3 \times W_4$. Sufficient nutrient supply to the rice plant from both cowdung and chemical fertilizers with effective control of weed by combined application of both pre- and post-emergence herbicides facilitated minimum competition of weed with crop resulted in the highest grain yield in $N_3 \times W_4$ through producing the highest number of total tillers $hill^{-1}$ and effective tillers $hill^{-1}$ compared to other treatment interactions. On the other hand, the lowest grain yield (4.05 t ha^{-1}) was found in cowdung 10 t ha^{-1} with no weeding ($N_1 \times W_0$) due to the lowest number of total tillers $hill^{-1}$ (6.07) and effective tillers $hill^{-1}$ (5.20) (Table 4). The

Table 2. Effect of nutrient management on crop characters, yield components, yield and weed dry matter at harvet of *boro* rice (cv. BRRI dhan63)

Nutrient management (N)†	Plant height (cm)	Total tillers hill^{-1}	Effect. tillers hill^{-1}	Panicle length (cm)	Grains number panicle^{-1}	Sterile spik. no. panicle^{-1}	1000 - grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	Weed DM (g m^{-2})
N_1	70.58 b	6.79 d	5.85 d	21.32	80.66 b	23.30 a	21.99	4.92 d	6.10 d	44.54 b	37.18 d
N_2	77.84 a	10.24 b	8.518 b	21.6	83.94 a	21.65 b	22.49	5.82 b	6.97 b	45.45 a	63.04 a
N_3	77.26 a	10.77 a	8.99 a	21.45	85.23 a	19.64 c	22.93	6.24 a	7.39 a	45.78 a	58.48 b
N_4	77.61 a	9.25c	7.83 c	21.51	81.04 b	22.26 ab	22.28	5.41 c	6.60 c	44.99 ab	45.19 c
SE	0.651	0.092	0.075	0.216	0.785	0.426	0.491	0.04	0.054	0.278	0.427
Sig. level	**	**	**	NS	**	**	NS	**	**	**	**
CV (%)	3.33	3.86	3.72	3.9	3.67	7.6	8.48	2.77	3.11	2.39	3.24

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); ** = Significant at 1% level of probability, NS = Non significant;
† N_1 = cowdung 10 t ha^{-1}, N_2 = recommended dose of chemical fertilizer, N_3 = 75% recommended dose of chemical fertilizer + cowdung 5 t ha†, and N_4 = 50% recommended dose of chemical fertilizer + cowdung 10 t ha^{-1}.

Table 3. Effect of weed management on crop characters, yield components, yield and weed dry matter at harvet of *boro* rice (cv. BRRI dhan63)

Weed management (W)†	Plant height (cm)	Total tillers hill^{-1}	Effect. tillers hill^{-1}	Panicle length (cm)	Grains number panicle^{-1}	Sterile spik. no. panicle^{-1}	1000 - grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	Weed DM (g m^{-2})
W_0	74.55 b	8.36 d	7.09 e	21.48	80.81 b	24.82 a	21.30 c	4.55 e	5.72 e	44.27 b	107.0 a
W_1	77.23 a	9.618 b	8.16 b	21.46	83.21 ab	20.59 cd	23.03 ab	6.05 b	7.30 b	45.29 a	26.66 d
W_2	75.10 ab	9.368 b	7.78 c	21.43	82.54 ab	21.37 bc	22.17 bc	5.79 c	6.90 c	45.53 a	31.58 c
W_3	75.24 ab	8.898 c	7.41 d	21.39	82.11 b	22.32 b	21.67 bc	5.21 d	6.28 d	45.26 a	67.83 b
W_4	76.99 a	10.08 a	8.54 a	21.59	84.92 a	19.45 d	23.95 a	6.39 a	7.62 a	45.60 a	21.78 e
SE	0.729	0.103	0.084	0.242	0.877	0.476	0.549	0.045	0.061	0.31	0.477
Sig. level	*	**	**	NS	*	**	**	**	**	*	**
CV (%)	3.33	3.86	3.72	3.9	3.67	7.6	8.48	2.77	3.11	2.39	3.24

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); *, ** = Significant at 5% and 1% levels of probability, repsectively, and NS = Non significant; † W_0 = weedy check, W_1 = hand weeding twice at 15 and 30 DAT, W_2 = Panida at 3 DAT, W_3 = Granite at 10 DAT, and W_4 = Panida at 3 DAT + Granite at 10 DAT.

lowest straw yield (5.33 t ha^{-1}) and biological yield (9.38 t ha^{-1}) were found also in the same treatment interaction. Insufficient supply of plant nutrients only from cowdung and severe weed competition with crop for growth resources might be the causes of poor performance in $N_1 \times W_0$. Roy et al. (2017) also found similar results.

3.4 Relationship between grain yield and weed dry matter

A negative relation between weed dry matter production and grain yield of *boro* rice (cv. BRRI dhan63) was observed due to different weed management strategies, which indicated that higher the weed dry matter production lower the grain yield (Aminpanah et al., 2014). The response of weed dry matter production to the grain yield of rice followed a linear negative relationship which could be adequately described by regression equation. The regression equation indicates that an increase in weed dry matter production would led to a decrease in the grain yield of rice (Fig. 1).

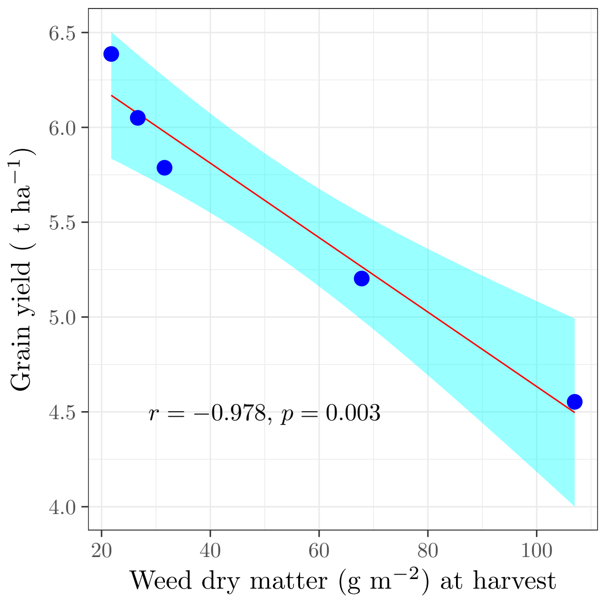

Figure 1. Relationship between grain yield and weed dry matter production at harvest of *boro* rice (cv. BRRI dhan63). The shade denotes the region of standard error.

Table 4. Interaction effects of nutrient and weed management on crop characters, yield components, yield and weed dry matter at harvet of *boro* rice (cv. BRRI dhan63)

Inter-action ($N \times W$)[†]	Plant height (cm)	Total tillers $hill^{-1}$	Effect. tillers $hill^{-1}$	Panicle length (cm)	Grains number $panicle^{-1}$	Sterile spik. no. $panicle^{-1}$	1000 - grain wt. (g)	Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Harvest index (%)	Weed DM ($g\ m^{-2}$)
$N_1 \times W_0$	69.56	6.07 k	5.20 g	21.24	79.03	27.66	21.07	4.05 m	5.33 h	43.17	74.73 d
$N_1 \times W_1$	70.16	7.13 ij	6.20 f	21.18	81.26	21.92	22.47	5.35 hi	6.50 ef	45.12	20.70 j
$N_1 \times W_2$	71.89	7.00 ij	6.00 f	21.33	80.28	22.47	21.93	4.88 jk	6.17 f	44.16	24.40 i
$N_1 \times W_3$	69.03	6.53 jk	5.46 g	21.51	79.98	23.88	21.13	4.70 k	5.80 g	44.75	50.00 f
$N_1 \times W_4$	72.27	7.27 i	6.40 f	21.35	82.77	20.56	23.33	5.60 gh	6.71 e	45.49	16.07 k
$N_2 \times W_0$	77	9.27 g	7.93 cd	21.62	81.66	25.43	21.27	4.72 k	5.75 g	45.08	142.8 a
$N_2 \times W_1$	79.37	10.87 bc	9.13 b	21.51	84.43	20.33	23.07	6.25 cd	7.60 bc	45.12	32.53 g
$N_2 \times W_2$	76.54	10.40 cde	8.13 cd	21.56	83.78	21.31	22.07	6.10 de	7.18 d	45.93	34.80 g
$N_2 \times W_3$	76.39	9.60 fg	8.07 cd	21.55	83.33	22.46	22.07	5.33 i	6.47 ef	45.17	77.33 d
$N_2 \times W_4$	79.89	11.07 b	9.33 b	21.77	86.5	18.71	24	6.68 b	7.85 b	45.97	27.73 h
$N_3 \times W_0$	77.42	9.87 efg	8.33 c	21.47	83.32	20.49	21.73	5.11 ij	6.30 f	44.79	129.7 b
$N_3 \times W_1$	77.79	11.00 bc	9.20 b	21.61	85.83	18.79	23.67	6.73 ab	7.89 b	46.03	29.27 h
$N_3 \times W_2$	75.7	10.67 bcd	8.93 b	21.3	85	19.96	22.6	6.50 bc	7.58 bc	46.16	34.00 g
$N_3 \times W_3$	76.79	10.13 def	8.40 c	21.27	84.57	20.44	22.13	5.89 ef	6.68 e	46.86	75.73 d
$N_3 \times W_4$	78.59	12.20 a	10.13 a	21.59	87.43	18.51	24.53	6.97 a	8.50 a	45.06	23.67 i
$N_4 \times W_0$	74.23	8.27 h	6.93 e	21.59	79.23	25.72	21.13	4.33 l	5.50 gh	44.06	80.73 c
$N_4 \times W_1$	81.59	9.47 g	8.13 cd	21.56	81.32	21.33	22.93	5.87 ef	7.21 d	44.88	24.13 i
$N_4 \times W_2$	76.27	9.40 g	8.07 cd	21.54	81.11	21.74	22.07	5.67 fg	6.69 e	45.88	33.13 g
$N_4 \times W_3$	78.74	9.33 g	7.73 d	21.22	80.56	22.49	21.33	4.90 jk	6.17 f	44.25	68.27 e
$N_4 \times W_4$	77.21	9.80 efg	8.33 c	21.64	82.96	20.02	23.93	6.30 cd	7.42 cd	45.89	19.67 j
SE	1.46	0.207	0.167	0.482	1.76	0.952	1.1	0.089	0.121	0.622	0.954
Sig. level	NS	*	*	NS	NS	NS	NS	*	*	NS	**
CV (%)	3.33	3.86	3.72	3.9	3.67	7.6	8.48	2.77	3.11	2.39	3.24

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); *, ** = Significant at 5% and 1% levels of probability, repsectively, and NS = Non significant;
[†] N_1 = cowdung 10 t ha^{-1}, N_2 = recommended dose of chemical fertilizer, N_3 = 75% recommended dose of chemical fertilizer + cowdung 5 t ha^{-1}, and N_4 = 50% recommended dose of chemical fertilizer + cowdung 10 t ha^{-1}, W_0 = weedy check, W_1 = hand weeding twice at 15 and 30 DAT, W_2 = Panida at 3 DAT, W_3 = Granite at 10 DAT, and W_4 = Panida at 3 DAT + Granite at 10 DAT.

4 Conclusion

The present research confirms that nutrient and weed management strategies plays a significant role on yield performance of *boro* rice (cv. BRRI dhan63). Based on the results of this study, it can be concluded that integrated use of cowdung with chemical fertilizer (75% recommended dose of chemical fertilizer + cowdung 5 t ha^{-1}) with combined application of both pre- and post-emergence herbicides (Panida at 3 DAT + Granite at 10 DAT) appeared as the promising practice in *boro* rice (cv. BRRI dhan63) cultivation in terms of grain yield.

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Conflict of interst

The authors declare that there is no conflict of interests regarding the publication of this paper.

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